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The impacts of the early outset of the COVID-19 pandemic on climate change research: Implications for policy-making

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ABSTRACT

Since January 2020, the COVID-19 pandemic has dominated the media and exercises pressure on governments worldwide. Apart from its effects on economies, education systems and societies, the pandemic has also influenced climate change research. This paper examines the extent to which COVID-19 has influenced climate change research worldwide during the first wave at the beginning of 2020 and how it is perceived to exploit it in the future. This study utilised an international survey involving those dedicated to climate change science and management research from Academia, Government, NGOs, and international agencies in 83 countries. The analysis of responses encompasses four independent variables: Institutions, Regions, Scientific Areas, and the level of economic development represented by the Human Development Index (HDI). Results show that: (1) COVID-19 modified the way the surveyed researchers work, (2) there are indicators that COVID-19 has already influenced the direction of climate change and adaptation policy implementation, and (3) respondents perceived (explicitly concerning the COVID-19 lockdowns of March-April 2020), that the pandemic has drawn attention away from climate policy. COVID- 19 has influenced the agenda of climate change research for more than half of

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the respondents and is likely to continue in the future, suggesting that the impacts on their research will still be felt for many years. The paper concludes by outlining critical implications for policy-making.

1. Introduction

Since the first infections of the SARS-Cov2 virus were reported to the World Health Organization office in China on December 31, 2019, the coronavirus crisis has quickly spread. It is currently causing a global problem with severe impacts on health, the economy and society. (Johns Hopkins University, 2020) According to Johns Hopkins University, as of May 28, 2021, over 169 million cases and 3.5 million deaths were reported worldwide.

Beyond infections and death, the pandemic's systemic effects are broad and far-reaching and complex like other sustainable development challenges. Negative impacts were reported about employment (McKeever, 2020), mental health and living conditions (Miki, 2020; Holmes et al., 2020), poverty (WEO, 2020), exacerbated acute hunger (World Food Programme, 2020), and led to substantial economic declines (Anthem, 2020). Simultaneously, alongside these broader devastating narratives, other impacts have been reported, highlighting the window of opportunities to push industry investments towards environmentally responsible technologies (e.g. The Economist, 2020). As highlighted by OECD (2020), COVID-19 poses challenges and opportunities on climate change mitigation efforts, which necessitate sustainable policy intervention through the integration of economy, research and climate mitigation advocacy.

Within this context, there have been long-standing propositions about the potential of visible, short-term socio-economic impacts of COVID-19 to change priorities in research, changing the perspective on dealing with long-term, uncertain and complex measure threats like environmental sustainability and climate change (Platje, 2011). For example, the daily stories and personal experience with COVID-19 measures, or the daily reports of infected, hospitalised beds in intensive care due to COVID-19, may draw attention away from more complex climate issues (e.g., Kahneman, 2011). As such, there is potential that in the short term, COVID-19 could draw attention away from the climate goals, while more attention may be given to COVID-19 research (a search on Google Scholar on September 14, 2020, gave 2.49 million hits for climate change, and 1.31 million hits for 'COVID-19').

Whilst this proposition remains untested mainly, there is a growing appetite to learn from the pandemic, especially in terms of how the dynamics of climate change (Barrett, 2020), the measures and mitigations to connect crisis and climate policy (Sauven, 2020), and the challenge to structures that underpin the socio-economic system (Van Dam and Webbink, 2020). In particular, there is increasing interest in how the collective recovery response could form part of, rather than be seen as separate from, our response to climate change (Wang et al., 2020; Rosenbloom and Markard, 2020).

This collective response includes climate change research, which is part of the ecosystem of climate change response and adaptation. This study seeks to examine the impacts that the COVID-19 crisis had on climate change research in the first wave of COVID-19 at the beginning of 2020 to inform broader policy response moving forward. Evidence from an international survey conducted in 83 countries conducted in April 2020 suggests that COVID-19: (1) modified how climate change researchers work, (2) influenced the direction of climate change and adaptation policy implementation, and (3) did indeed draw attention away from climate policy.

This article is structured as follows. First, it outlines the linkages between the COVID-19 and climate change, followed by the methods section setting and three propositions developed from the literature. Then it analyses the key propositions about how COVID-19 interplays with the survey participants' research agenda. The final section discusses the implications of the data for policymakers.

2. COVID-19 and climate change

Evidence to date has highlighted the complex, systemic effects of the pandemic, as highlighted above. In terms of climate change, in particular, there is contradictory evidence. On the one hand, economic activities in sectors responsible for substantial greenhouse gas (GHG) emissions have all but collapsed due to the lockdown strategy adopted by most governments worldwide. The aviation industry has suffered a severe setback as governments cancelled or reduced flights. Indeed, all transport sectors' amount of petroleum fell dramatically (Rugani and Caro, 2020). In the same vein, industrial production's closure and downsizing have considerably restricted GHG emissions (Purdy, 2020; Cooper, 2020; Stone, 2020).

On the other hand, the 'stay home' policy adopted worldwide has caused an increase (Rugani and Caro, 2020) in utilising electric and natural gas consumption at the household level, thereby increasing GHG emissions (Hamwey, 2020). A recent article (Halbrügge et al., 2021) states that "the first wave of the COVID-19 pandemic led to decreases in electricity demand and a rising share of Renewable Energy Sources in Germany and France".

The measures taken by national governments and international organisations in media coverage suggests how the COVID-19 pandemic influences climate change and climate change research (Berwyn, 2020; Martinez-Diaz and Sidner, 2020). The pandemic has prompted responses such as quarantines, travel restrictions, and organisations' closures. While this can be appreciated by preventing the spread of the virus to rural villages, it has had the undesirable effect of cancelling climate data recording (Berwyn, 2020). Similarly, there are reports about temporary measures against the maintenance and monitoring of natural ecosystems (Hamwey, 2020).

As such, policy-makers risk underestimating the impact of COVID-19 on the climate change adaptation efforts of poor agri-pastoralists, especially in developing countries (Wynes, 2020; U.N., 2020; Martinez-Diaz and Sidner, 2020). Because of disruptions in global connectedness, farmers could face restrictions in reaching their customers. The export market decrease could have far-reaching ramifications on household employment and national Gross Domestic Product (GDP).

Globally, there are significant research efforts invested in understanding the dynamics of the COVID-19 virus and controlling the pandemic. As national governments target the COVID-19 pandemic, it is not surprising that health preoccupations could eclipse climate change priorities. In this regard, COVID-19 offers a substantial situational case study that explores how a pandemic exposes the vulnerability of various sectors to climate change and variability manifestations (U.N., 2020; Martinez-Diaz and Sidner, 2020).

As a result, it appears that broader research activity into sustainable development research has been affected; academic forums have moved online, and funding and existing budgets have been shifted towards COVID-19 crisis action, and research centres have been closed (Leal Filho et al., 2020a). Indeed, the education system has changed dramatically to accommodate the new context, emphasising e-learning and digital platforms (Ali, 2020; Crawford et al., 2020; Leal Filho et al., 2021). Similarly, researchers' free movement restrictions preclude their field data collection ability, promoting more desk research opportunities (Berwyn, 2020).

However, the U.N. Secretary-General warns that climate change remains a threat regardless of the eventual defeat of COVID-19 (Gornall, 2020). The likely loss of research centre capacity and the lacking promise of governmental financial relief thus far suggest that climate change research efforts will be negatively affected (Clarkson, 2020). The above literature highlights three currently untested propositions:

Proposition 1. COVID-19 has and will continue to change how climate change research work is undertaken.

Proposition 2. COVID 19 will change the direction of climate policy research.

Proposition 3. COVID-19 will draw attention away from climate policy.

The propositions guided the research undertaken in the framework of this paper and were used as departing points for the subsequent analysis. They will be examined in section 4.5 and the Discussion.

3. Methods

This study aims to examine the global impact of COVID-19 on climate change research. Specifically, it analyses the three propositions developed from the literature: (P1) COVID-19 has and will continue to change how climate change research work is undertaken, (P2) COVID 19 will change the direction of climate policy research, and (P3) COVID-19 will draw attention away from climate policy.

3.1. Instrument

Data collection for the study followed a structured questionnaire survey to understand the effects of COVID-19 on climate change research. The questions were designed to probe areas of competing priorities between COVID-19 and climate change. It was organised into three sections. The first section sought to characterise the sociographic respondent information. The second addressed the immediate impacts of the shutdown in work in general and climate research in particular. The last section sought to understand the impact of future climate change research.

Although the tool allocated some space for open-ended questions, overall, the survey instrument essentially comprised twenty-four closed-ended questions. A subsequent statistical analysis was performed (Punch, 2014; Creswell, 2013, 2014). The survey design was adopted to benefit from a 'rapid turnaround in data collection' (Creswell and Creswell, 2018, p. 149), which was deemed a key criterion for this research's timely and swift execution.

The data collection instrument was developed through an iterative process that solicited input and feedback from a multi-national team of climate change researchers. The data collection instrument was then pre-tested, which led to minor adjustments but overall confirmed the instrument's adequacy (Bryman, 2016, pp. 260–261). Purposive sampling ensured that the survey instrument was well received by the appropriate respondent target group, which comprised of academics researching a broad range of areas related to climate change science and management. Data collection was not unduly limited to researchers within the International Climate Change and Research Programme (ICCIRP) (https://www.preventionweb.net/organizations/6469). Additional snowball sampling was carried out involving the author's networks, including researchers from the Higher Education Institutions (HEIs), Government, Non-Governmental Organisations (ONGs) and International Organisations. Furthermore, the snowball sampling 'capitalises on individuals' connectedness in research networks' (Bryman, 2016, p. 415).

The questionnaire available through the online Google forms platform tool over two weeks (12–26 April 2020).

3.2. Analysis

To analyse the survey, we used descriptive statistical analysis to characterise the response trends. The respondents' citations, to which the analysis refers, result from the open questions mentioned and allowed for support analysis, illustrated by the respondents' subjective views of the situation. These responses were analysed through content analysis: coding and categorisation (Creswell and Creswell, 2018).

The responses are divided into four independent variables categories: i) Institutions; ii) Regions; iii) Scientific areas, IV) Human Development Index (HDI) of the respondents' 83 countries. The HDI aggregation was created because the variable "Regions" does not include Oceania due to its low number of countries (N = 5). The HDI organises indicators into three dimensions of human wellbeing: health, education, and income, classed as very low, low, medium, high, and very high HDI countries (UNDP, 2015).

The inferential analysis of the data was performed using statistical software (SPSS). Statistical significances for variables were determined using Pearson's chi-square test (if Chi-square < 0.05= Significant; if > 0.05= Non-significant).

3.3. Sample

The sample entails 501 respondents (N) from 83 countries (Fig. 1*);* 39 % were female, and 61 % were male (Fig. 2a). A third of them were researchers in Social Sciences (33 %), followed by Exact and Earth Sciences (16 %), Biological Sciences and Agrarian Sciences (11 % each). Eighteen per cent of the respondents worked in Business, Humanities, Engineering, Law or Management (Fig. 2b). Finally, Fig. 2c shows the institutions where respondents are developing their works, coming from Universities and research centres (72 %), followed by the International organisation and U.N. Agency (15 %). Government agency, private companies, NGOs and Foundations complete the institutions.

3.4. Propositions

The support to the propositions (Ps 1–3) is schematised through flowcharts of the responses to the questionnaire, the propositions, and related statements presented in Section 4.5.

4. Results

4.1. Descriptive statistics

Tables 1 and 2 present the survey questions' descriptive statistics and the responses, without discrimination of gender, country, or scientific areas.

The countries (N = 83) most represented in the survey (Fig. 1) were Germany (N = 40), Nigeria (N = 34), The USA (N = 31), Portugal (N = 21), and India (N = 18). Fig. 2 shows the responses to the questions (Q) 1–7 (Background).

Table 1 summarises the responses to questions 7–18 (The shutdown and your work). The answers are combined to highlight the contrasting responses (e.g. agree and totally agree, disagree and totally disagree, and neutral).

4.2. Implications of the shutdown due to the COVID-19 crisis

Table 1 shows how the shutdown due to COVID-19 had influenced the survey respondents' research work. More than 60 % of the respondents declared that the shutdown had affected them to perform usual climate change research at their institutions for more than two weeks, stating half of them an influence of more than one month. However, most of them (85.2 %) indicated that they agreed with the measures adopted by their institutions, and 82.3 % asserted they were working at home during this time, and only 4.3 % had to stop their work thoroughly.

Several applications were employed to maintain communication during the shutdown, being Zoom (35 %) and Skype (34 %) the main ones. Around 80 % of the participants indicated that the available infrastructure to perform their research activities from home was acceptable or good. Similar results were found when assessing the support given by their organisations. Notwithstanding, 78.8 % informed

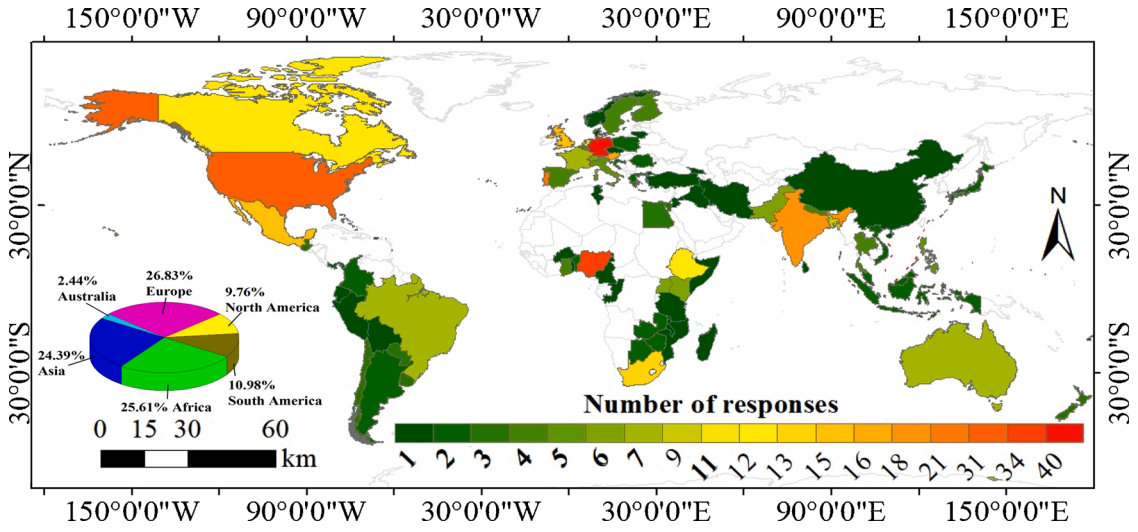

Fig. 1. Country and regional distribution and number of responses.

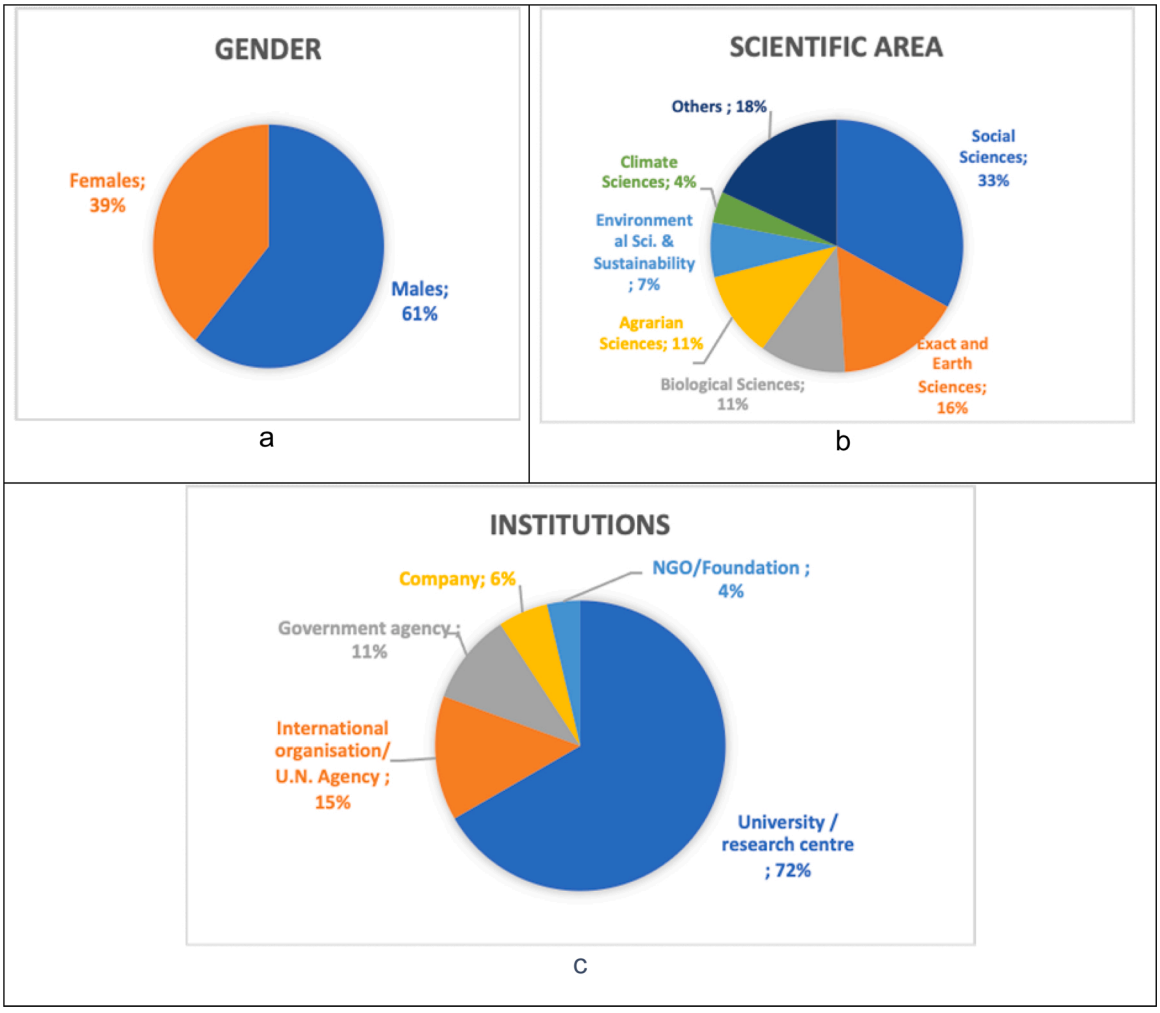

Fig. 2. Distributions of the participants: Gender (a), Scientific Areas of research (b) and Institutions (c).

that their climate researches and projects were affected to some extent, being the main problems related to delays (17 %), the cancellation of project meetings (16 %), and the inability to collect data (15 %).

These causes were repeated when asking about their workload. Although the pandemic has affected their work to some extent, half of them declared their workload has increased due to different reasons. Many refer to institutions' organisations to cope with COVID-19 safety measures like converting their classes into a virtual lesson or the time spent in video meetings. Family reconciliation was another problem that emerged in their explanations, with methodological changes in current

Table 1
Descriptive statistics of the survey: Part 2- The shutdown and your work.

Questions	VALID	Responses
Q7. How long have you been affected by the shutdown and unable to perform normal climate change research at your institution?	417	**Between 1–2 months (33.1%)** **Between 2 weeks to 1 month (32.9 %)** Not at all (19.2 %) More than two months (9.6 %) Between 1–2 weeks (5.3 %)
Q8. To which extent do you agree with the actions taken by your organisation to cope with the shutdown of the operations during this period?	417	**Agree (85.2 %)** Disagree (9.3 %) I neither agree nor disagree (5.5 %)
Q9. During the crisis, you are/have:	418	**Working regularly at "home office" (only) (82.3 %)** Regularly shuttling between home and office/laboratory (10.3 %) Stopped working (4.3) Working regularly from office/ laboratory (3.1 %)
Q10. Which tools, apart from e-mail, have you used for communication during the shutdown?	407	**Zoom (35.0 %)** **Skype (34.0 %)** Microsoft Teams: (15.0 %) WebEx (5.0 %) Other (11.0 %)
Q11. Considering the challenges of working away from your office, how do you evaluate the available infrastructure to perform your research activities on climate change from home?	418	**Good (42.8 %)** **Acceptable (38.0 %)** Insufficient (19.1 %)
Q12. How do you evaluate the support given by your organisation to your research work during the shutdown?	418	**Good (44.8 %)** Acceptable (34.2 %) Insufficient (21.0 %)
Q13. To what extent has the shutdown influenced your research and/or your project work on climate change?	417	**Affected (50.6 %)** To some extent (28.1 %) Not affected (21.3 %)
Q14. During the shutdown, which problems have you experienced in your climate change research?	406	**Delays (17.0 %)** **Project meetings were cancelled (16 %)** Project schedules had to be substantially adjusted (11.0 %) Unable to collect data (15.0 %) Difficulty in combining research work with family (14.0 %) Communication was disrupted (11.0 %) Others (15.0 %)
Q15. How do you rate the impacts of the COVID-19 crisis on your research workload?	417	**Increased (51.8 %)** No impact (25.7 %) Decreased (23.3 %)
Q16. How do you evaluate the impact of COVID-19 in your climate change research content-wise?	297	**Negative (40.0 %)** Positive (30.0 %) Little change (17.0 %) Not clear yet (8.0 %) Others (5.0 %)
Q17. Which are/were the main challenges of COVID-19 to your climate change research?	371	**Lack of personal interactions/ dialogues with colleagues/staff (50.1 %)** Lack of materials/resources (21.3 %) Lack of interest/motivation from fellow researchers (11.9 %) Lack of support from the administration (8.6 %) Lack of expertise regarding new technologies (8.1 %)
Q18. Has the shutdown led to new ideas or new orientation for your research?	412	Yes (67.5 %) No (32.5 %)

Note: N = 501. The most relevant(s) response(s) are in bold.

Table 2
Descriptive statistics of the survey: Part 3-. The future.

Questions	N VALID	Responses
Q19. The shutdown has led to lower CO2 emissions. Nevertheless, do you expect the COVID-19 epidemic to have an impact on climate change research and policy?	415	**Yes (82.7 %)** No (17.3 %)
Q19.1. If YES, which main impacts do you expect? (multiple answers possible)	367	**Policymakers, practitioners and the scientific community can draw lessons about the devastative event and design context-specific policies and strategies** (24.4 %) **It forces governments and donors to reallocate climate adaptation and mitigation budget to COVID-19 epidemic prevention and response (23.6 %)** **It takes the attention away, leading to emphasise short-term economic and social interests instead of long-term climate impacts** (23.5 %) It focuses the attention, leading to higher emphasis on climate issues in the future (12.0 %) It takes the attention away, leading to a lower emphasis on climate issues in the future (6.5 %)
Q20. Will the COVID-19 crisis influence your research in the long-term?	418	**Yes (65.3 %)** Unsure (30.0 %) No (6.7 %)
Q20.1. If "Yes", in which ways?	317	**More use of on IT-based communication/home office approach (43.4 %)** Lower attendance to physical events (20.4 %) Consider the possibility of "extreme events" when preparing research schedules (12.0 %) Less travel (9.3 %
Q21. Have you planned or do you plan to include references to the COVID-19 epidemic or used /or plan to use it as a theme in any of your future climate change research projects?	411	**Yes (68.0 %)** No (32.0 %)
21.1. If YES, what form has this taken, or will it take?	286	**As a component of a project (79.5 %)** The main theme of a project (19.1 %)
22. Has COVID-19 influenced you to adapt/change the direction of your climate change research?	415	Yes (33.5 %) **No (66.5 %)**
22.1. If YES, what form has this taken?	103	**Human vulnerability, global community and sustainability, climate actions and research (70.2 %)** To foster COVID 19 outbreaks action and research (14.6 %) 24.2 % (Others) Climate change and health issues (4.8 %)
Q23.1. The impact of the COVID-19 crisis on life as we knew it made me change the way I interpret change	420	**Agree (49.8 %)** Neutral (25.6 %) Disagree (24.5 %) *
Q23.2. I have revised my research methods to highlight the impacts of the COVID-19 crisis on climate change efforts	425	**Disagree (73.1 %)** * Agree (25.7 %) Neutral (25 %)
	425	**Disagree (47 %)** * Agree (39.6 %)

(*continued on next page*)

Table 2 (*continued*)

Questions	N VALID	Responses
Q23.3. I have added COVID-19 as a topic on my current research activities (studies, surveys …)		Neutral (16 %)
Q23.4. Despite all challenges, Covid-19 provided some positive impacts (reducing carbon emissions, saving time)	423	**Agree (62.4 %)** Neutral (21 %) Disagree (16.1 %) *
Q23.5. COVID-19 may change the way universities research (for adding more online meetings and resources)	424	**Agree (76.6 %)** Disagree (8,7%) * Neutral (14 %)
Q23.6. Covid-19 may change fieldwork methodologies (for adding more online techniques, for example, online interviews, online focus groups)	423	**Agree (67.9 %)** Neutral (20.4 %) Disagree (11.7 %) *
Q23.7. I expect that global cooperation on tackling COVID19 will galvanise global cooperation on tackling climate change	422	**Agree (43.3 %)** * Neutral (31.7 %) Disagree (24.7 %)
Q23.8. I expect that global cooperation on tackling COVID19 will likely divert attention and resources away from global action on climate change	419	**Agree (45.0 %)** Neutral (28,6 %) Disagree (25.8 %)
Q24. If relevant, please indicate other aspects related to the impact of COVID-19 on climate change research that you consider important and that were not addressed in the previous questions.	376	**Link between climate change, COVID-19, and health (36.3 %)** Link between COVID 19 and sustainability (21 %) Economic impacts caused by COVID 19 on climate change actions (19.6 %) Impacts of COVID 19 on gender and justice (16.7 %)

Note: N = 501. The prevailing response(s) are in bold.

* *Question* 23, the extent of agreement on a Lickert scale 1–5. Aggregated responses: 1 and 2 as *Disagree*; 3 as *Neutral*; 4 and 5 as *Agree*.

research related to the inability to apply questionnaires already designed and validated. Nevertheless, some of them indicated they had found several opportunities for researching with international collaborations, which is why their workload increased.

On the contrary, 23.3 % informed their workload decreased due to several reasons: some related to researchers working alone or are in an active phase like literature review or data analysis. They indicated their workload has decreased because they are working more hours than before. Others said that their workload was the same as before or that a cancelled project allows them to focus on other issues.

Table 2 shows the responses to questions 19–24 (The future) focused on the respondents' perceptions about the pandemic's expected impacts on their research, including the COVID 19 topic, research methods, online activities, and the reduction of meetings and fieldwork.

For instance, 47 % of the respondents answered that the pandemic forces reallocating climate management funds, taking the attention away from long-term climate issues. Other 24 % responded that the scientific community could draw lessons about the pandemic and design context-specific policies and strategies. Most respondents (65 %) agree that COVID 19 crisis will change their future research, mainly due to the increased use of IT-based communication and working from home, and 76 % said that the way universities research would change, such as fieldwork approaches (69 %). Only 25 % envisage changing their research methods to highlight COVID impacts.

4.3. Inferential statistics

4.3.1. Descriptive variables

This subsection presents an inferential analysis and the significance (if $\alpha = <0.05$). The answers offered differences for gender, particularly with the HDI aggregation; nevertheless, gender did not show differences with institutions, and therefore, it was not retained as a variable. The Institution vs Region analysis did not offer differences, while the Institution vs Scientific area (henceforth Scientific) did so.

The analysis encompasses the four independent variables: Institutions, Regions, Scientific, and HDI. HDI was divided into very high (V.H.) and Others (including High, Medium and Low HDI countries) to have a similar size. The countries from Oceania are accounted in both HDI groups, which reshape the regional distribution (e.g. Australia, New Zealand, Argentina, Chile, Uruguay, and Malaysia are grouped in the V. H. group).

In Tables 3–5, only the statistically significant responses are detailed.

Table 3
Synthesis of inferential analysis I: Regional Aggregation. Questions (Q) 8-23.

	Regions
Q7	The less affected (less than one month) were Asians (59 %) and Africans (50 %). The most affected (2+ months) were North Americans (52 %), LACs (46 %) and Europeans (45 %).
Q10	Zoom platform was the preferred tool, e.g. 98 % (North America), 60 % (Africa). Skype was popular in Europe (76 %) and North America (67 %). Microsoft Teams was popular in Asia (56 %) and LAC (51 %).
Q11	Acceptable was the first option in Asia (55 %) "Good" prevailed in Europe (42 %). "Very poor" was high only in Africa (44 %). "Very good" was maximum in North America (27 %), and the lowest in Africa (7 %).
Q12	Good/very good" (as of now Good) prevailed in North America (70 %), whereas the lowest was in Africa (30 %). "Poor" achieved 46 % in Africa. Acceptable prevailed in LAC (43 %).
Q13	The primary response was "to some extent" (e.g., 30 % in North America) "To a moderate extent", prevailed in Asia (32 %) "To a great extent" prevailed in Africa (38 %) and "a little bit" in Europe (26 %).
Q14	"Project schedules had to be substantially adjusted" prevailed overall, reaching a maximum in North America (71 %). "Unable to collect data" prevailed in Asia (59 %) "Project meetings were cancelled" prevailed in Africa (57 %). The option "delays" prevailed in North America (66 %).
Q15	"Research workload moderately increased" was the maximum in North America (45 %) "It decreased" prevailed in Africa and Asia (26 and 25 %, respectively) "It had no impact" prevailed in Europe (40 %)
Q20	"Workload has greatly increased" was selected by 28 % from Africa. The average of YES was 65 % (maximum in Africa: 77 %), whereas unsure was maximum in Asia (38 %).
Q20.1	Communication Technologies from the home office reached 39 % (maximum in LAC at 57 %) "Less travel" achieved 17 %, with a maximum in North America (28 %) and the lowest in LAC (7 %).
Q21.1	"As a component of a project" reached 73 %, with the maximum in LAC (91 %) and the minimum in Asia (65 %).
Q22	Two-thirds responded NOT with the maximum from Europe (74 %), and the minimum from Asia (50 %) The maximum for YES was from Asia (50 %), and the minimum was from Europe (26 %).
Q23.2	Disagreement averaged 50 %, with a maximum from North America (60 %) The agreement was 24 %. Neutral was 25 %, with a maximum from Asia (38 %).
Q23.4	Agreement averaged 62 %, with the maximum from Asia (71 %) and the minimum from North America (49 %).
Q23.6	Agreement averaged 68 %, with a maximum from North America (74 %) and a minimum from Europe (64 %). Disagreement averaged 12 %. Neutrality was 21 %.

Note: See Table 2 for more information on the statements of the questions.

Table 4
Synthesis of inferential analysis II: Scientific areas aggregation and HDI aggregation. Questions Q 8 to 23.

	Scientific Areas	HDI
Q7	The less affected was Biological Sciences (53 %). The most affected was Agrarian Sciences (52 %).	V.H. was less affected than Others, e.g., not at all (41 %).
Q8	The agreement was highest from Climate Sciences (93 %). The disagreement was highest from Exact & Earth Sciences (13 %).	
Q9	Working at home averaged 83 %. The maximum and minimum were Climate Sciences (93 %) and Agrarian Sciences (75 %). Regularly shuttling between home/office prevailed in Agrarian Sciences (16 %). Working from office/Lab prevailed in Earth & Exact Sciences (7%). Have stopped working prevailed in Agrarian Sciences (9%).	V.H. shows that 89 % are working from the home office, and 0.5 % have stopped working, against 75 %, and 9 % that stopped working, in Others.
Q11	"Insufficient" available Infrastructure averaged 19 % with a maximum from Biological Sciences (28 %) and a minimum from Social Sciences (14 %).	V.H. countries show much less "Insufficient" (8 %) answers than Others (34 %).
	"Good" averaged 43 %, with a maximum from Social Sciences (51 %) and a minimum from Biological Sciences (23 %).	In contrast, the opposite prevailed for "Good available infrastructure" (57 %, against 27 %, respectively).
Q12	"Insufficient" was maximum from Agrarian Sciences (32 %) and minimum from Climate Sciences (13 %).	Thirty-six per cent of Others responses are "Insufficient" against less than 10 per cent in V.H.
	"Good" averaged 47 %, with a maximum from Climate Sciences (67 %) and a minimum from Agrarian Sciences (16 %).	"Good" responses are 27 % in the former, against 60 % in the latter.
Q13		"A little bit and to a great extent" are significantly different, reaching 24 and 15 % respectively in V.H., and 8 and 34 % in Others.
Q14		The only significant response was YES for "Unable to collect data" (52 %) of Others, against 32 % in V.H. countries.
Q15	Workload decrease averaged 23 %, e.g. Environmental Sciences (41 %). The increase averaged 51 %, e.g., Climate Sciences (67 %) and Biological Sciences (43 %).	The "Workload decreased" reached 35 and 18 % in Others and V.H. countries respectively. "It moderately increased" did 56 and 46 % in Others and V.H. countries respectively. "Not impact" reached 13 and 36 %, respectively.
Q20.1		"More technological approaches from home/the office" prevailed in Others (40 %), followed by "Lower attendance to a physical event" (18 %). "Less travel" reached 22 % in V.H. countries, against 21 % for Others, and 18 % for "Lower attendance to physical events".
Q21		YES achieved 75 and 62 % in Others and V.H., respectively.
Q22		The answer Not reached 57 and 74 % in Others and V.H., respectively.
Q23.1	Agreement averaged 50 %, with maximum from Agrarian and Climate Sciences (53 %).	
Q23.2	Disagreement averaged 50 %, e.g. Exact and Earth Sciences (60 %) and Climate Sciences (20 %).	
Q23.3	The disagreement was 66 % from Agrarian Sciences.	
Q23.4	"Agree" averaged 63 %, with a maximum from Biological Sciences (76 %).	"Agree" reached 69 and 56 % in Others and V.H., respectively. Disagreement achieved 14 and 18 %, respectively.
Q23.5	Agreement averaged 77 %, with a maximum from Climate Sciences (87 %).	
Q23.6	Agreement averaged 68 %, with a maximum from Environmental Sciences (78 %).	The agreement reached 69 and 67 % in Others and V.H., respectively. The disagreement was 12 % in both aggregations.
Q23.7		The agreement reached 53 and 34 % in Others and V.H., respectively. Disagreements were 20 and 30 % in Others and V.H., respectively. Neutrality was 36 % in V.H. countries.

Note: Academia = University/Research Centre. HDI: Human Development Index; V.H. = Very High HDI. Very poor and Poor options were combined as insufficient. See Table 3 for more information on the statements of the questions.

Table 5
Cross-comparison of the significance (X) of the aggregations.

Question	Institutions	Regions	Scientific areas	HDI
Q 7.		X	X	X
Q 8.			X	
Q 9.			X	X
Q 10.		X		X
Q 11		X	X	X
Q 12.		X	X	X
Q 13.		X		X
Q 14.		X		
Q 15.		X	X	X
Q 18.	X			
Q 20.		X		
Q 20.1	X	X		X
Q 21.				X
Q 21.1		X		
Q 22.	X	X		X
Q 23.1	X		X	
Q 23.2		X	X	
Q 23.3			X	
Q 23.4		X	X	X
Q 23.5			X	
Q 23.6		X	X	X
Q 23.7				X

Note: See Table 2 for more information on the questions' statements.
*$\alpha < 0.05$ (Chi-Square test).

4.3.1.1. Institutional aggregation (institutions). The Institution Aggregation includes Academia (University/Research Centres), Government, Company, NGOs and International Organisations (International).

Only four questions received significant answers (Q18, Q20.1, Q22, and Q23.1). Regarding Q18 (Has the shutdown led to new ideas or new orientation for your research?), the answer YES prevailed (68 %) except in government, with the maximum from NGOs (85 %). The answer to Q20.1 (Will the COVID19 crisis influence your research in the long-term), the answer YES reached 65 %, 38 % of which for IT-Communication and Working from Home, varying from 28 % (Government) to 61 % (Companies). In respect of Q 22 (Has COVID-19 influenced you to adapt/change the direction of your research), the disagreement (answer NO) varied from only 29 % (International) to a high 72 % (Academia). Concerning Q 23.1 (The impact of the COVID crisis on life as we knew it made me change the way I interpret change), the agreement varied from 44 % (Academia) to 69 % (International); the disagreement was maximum from Academia (28 %).

4.3.1.2. Region aggregation (region). The Region Aggregation (Table 3) includes all the countries clustered in continents shown in Figs. 1 and 3 (except Oceania).

4.3.1.3. The scientific aggregation (scientific). The Scientific Aggregation analysis (Table 4) focuses on Social, Exact and Earth, Biological, Agrarian, Climate, and Environmental Sciences, which offered statistical differences with gender, countries, continents, and institutions.

4.3.1.4. HDI aggregation (HDI). The HDI Aggregation (Table 4) separates the countries into Very High HDI (V.H.) and Others (Fig. 3). The former accounts for 222 of the valid responses (N = 408) of the aggregation.

Regarding Q7, How long have you been affected….? The aggregation Very High (V.H.) was less affected (e.g., Not at all: 41 %). Working at Home / Stopped working (Q9) reached 89 and 0.5 % and 75 and 9% from V.H. and Others, respectively. Regarding the infrastructure for working at home (Q11), the answer "Insufficient" was 8% and 34 % for V.H. and Others, respectively. For Q12 (Support given by the organisation), the answer "Insufficient" reached 36 % from Others, against only 10 % from V.H. Regarding Q13 (influence on research/projects), the answer "to a great extent" was 15 and 34 % from V.H. and Others, respectively. As to the problems in climate change research (Q14), the only significant response was for "Unable to collect data" (32 and 52 % from V.H. and Others, respectively). The workload decreased / moderately increased (Q15) reached 35 and 56 % for V.H., and 18 and 46 % for Others. Regarding Q20 (…influence on the long-term research), more I. T. approaches from home reached 40 % in Others, whereas "Less travel" got 22 % from V.H. In respect of Q 21 (inclusion of COVID19 in future research), the agreements were 75 and 62 % from Others and V.H., respectively, whereas for Q22 (influence to adapt/change the research direction) reached 57 and 74 % respectively. For Q23.4 (Positive impacts), the answer was greater from Others (69 %) than from V.H. (56 %), while regarding the change in fieldwork methodology (Q23.6), the agreement was similar, 69 and 67 %, respectively. Finally, for Q23.7 (global cooperation on COVID19 will galvanise cooperation on tackling climate change), the agreement was high for Others (53 %), against 34 % from V.H., whereas disagreement reached 20 and 30 %, respectively. Table 5 summarises the significance of the four aggregations (see 4.4).

4.4. Overview of the main results

The institutional aggregation only has four significant responses (See Table 5) in 31 options, whereas Scientific, HDI and Regions have 12, 13 and 14, respectively. No response is significant for all aggregations, while only four (16, 17, 19, and 23.8) have non-significant answers. Noteworthy, four questions received only one significant response from the four different aggregations. Q8 (Agreement with the actions taken by your organisation) from Scientific Areas; Q18 (Has the shutdown led to new ideas…….for your research), from the Institution aggregation, except for Government; Q21.1 (Inclusion of references to COVID 19 in your research (projects), from Regions; Q23.7 (Global cooperation on tackling climate change), from HDI.

Several responses to "The shutdown and your work "(e.g. Qs 7–9, 10–12, 18) show that HEIs face problems because of the pandemic worldwide, which is not observed in the Institutions but the Regions, particularly in the Scientific and HDI aggregations (Tables 4–6). The answer "Not able to collect data" affected mainly the Biological Sciences (61 %). The responses to Q11 (infrastructure) show that "Others" (e.g., Africa) is more affected than V.H. (Table 4).

The responses to "The future" (e.g., Q18, 19–21) do not support the change in the focus of research not related to the pandemic. Only Q18 in the institutional aggregation (mainly NGOs) and Q21 in the Institutions and HDI are statistically significant.

The responses to Qs 15–18 support the change in climate change research "an increase in the workload" (Q15, e.g. Climate Sciences), and less so in the Institutional and HDI aggregations.

The responses to Qs 19–20 do not support that COVID-19 could positively influence climate change research and policy. However, the positive reaction is significant in the Institutions, Regions and HDI aggregations, e.g., the increase in the use of information technologies (with a maximum in LAC). Q21 supports the inclusion of COVID-19 in future climate change research in Regions, especially in LAC. The negative responses to Q22 (Has COVID-19 influenced you to adapt/change your climate change research direction) do not support the research focused on climate change in the Institutions, Regions HDI aggregations.

The responses Q23.4 (COVID-19 provided some positive impacts) and 23.7 ("expect that global cooperation on tackling COVID19 will galvanise global cooperation on tackling climate change") support positive changes. The former is positive and significant in the Regions (e.g., Asia), Scientific (e.g., Biological Sciences), and HDI (e.g., Others) aggregations. The latter is only significant in HDI, especially in "Others". The responses to Q23.8 ("I expect that global cooperation on tackling COVID19 will likely divert attention and resources away from global action on climate change") are not significant despite the agreement of 45 % of the respondents.

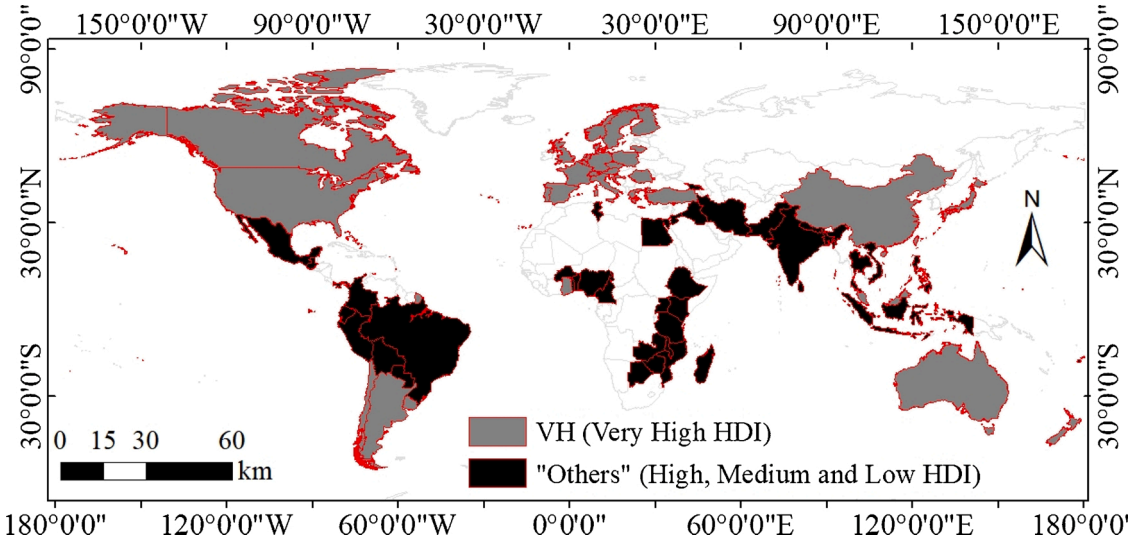

Fig. 3. Distribution of "Very High" and "Others" HDI aggregation.

4.5. Support to the propositions

The flowcharts of the responses to the questionnaire, the propositions, and selected statements are schematised in Figs. 4–6.

The Q12, Q13, Q15, and Q18 ("The shutdown and your work") support P-1 (online work and new ideas for research), while Qs17–18 corroborate P-2 (new orientations for research dynamics and research collaborations). The Q17 (adaptation to technology) is not significant in any of the aggregations.

The responses to Q19 (N.S.), Q20, Q21, and Q23 ("The future) support P-1 and P-2 (Fig. 4).

Q18 and Q22 (Institutions), Q20 and Q22 (Regions), and Q22 (Scientific areas) support P-3, as well as Q23.8 (non-significant).

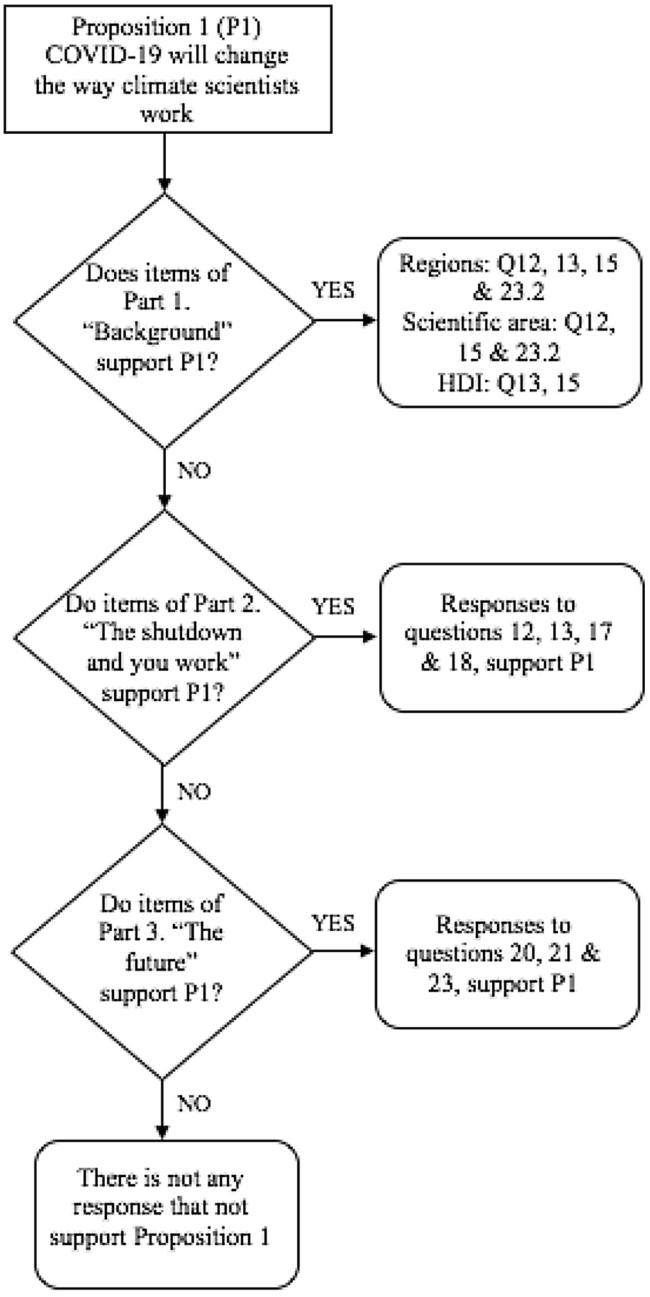

Fig. 4. Flowcharts showing the responses to the survey's parts and their relationship with P-1 and selected statements.

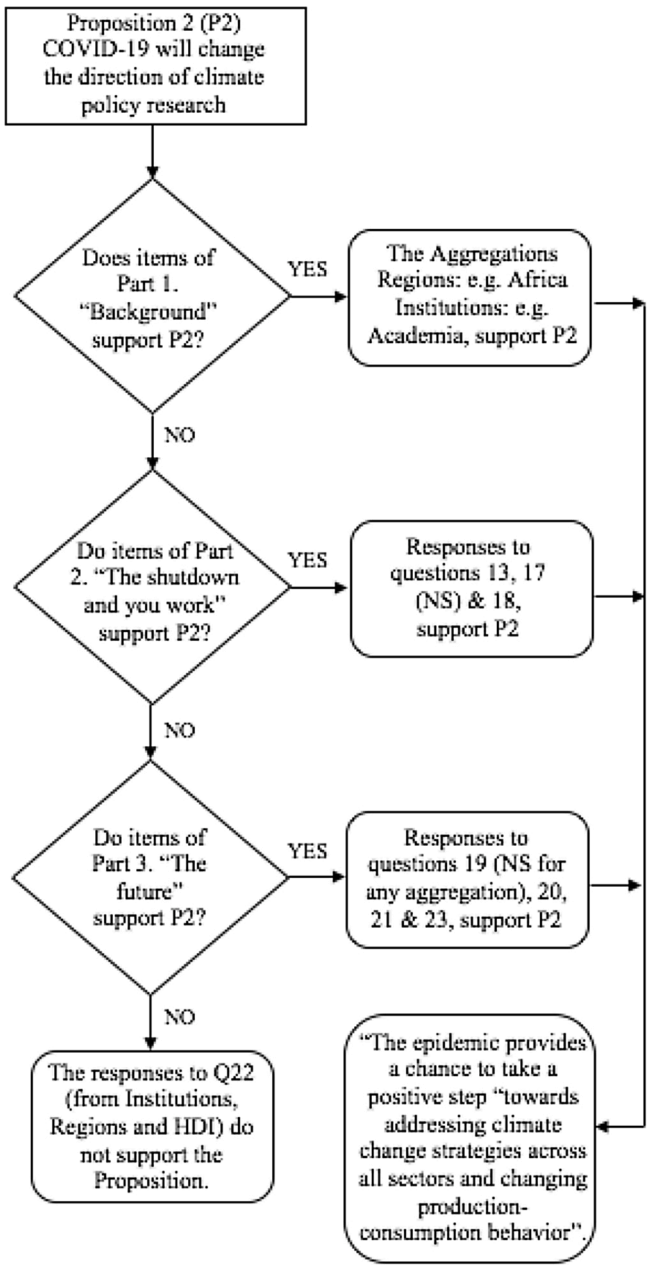

Fig. 5. Flowcharts showing the responses to the survey's parts and their relationship with P-2 and selected statements (N.S. non-significant).

5. Discussion

5.1. COVID19 and climate change as global crises

The COVID-19 pandemic revealed the global society's weaknesses and highlighted its unpreparedness. For instance, factors like population density, urbanisation and mass travel can have global impacts. Similarly, comparisons can be drawn between the pandemic and climate because both are influenced by unsustainability (transport and food systems), impacting people's health and increasing world inequalities (Botzen et al., 2020).

5.2. The responses to the survey and the propositions

Eighty-seven per cent of the questions received a significant response; nevertheless, none received a unanimous response. Regarding

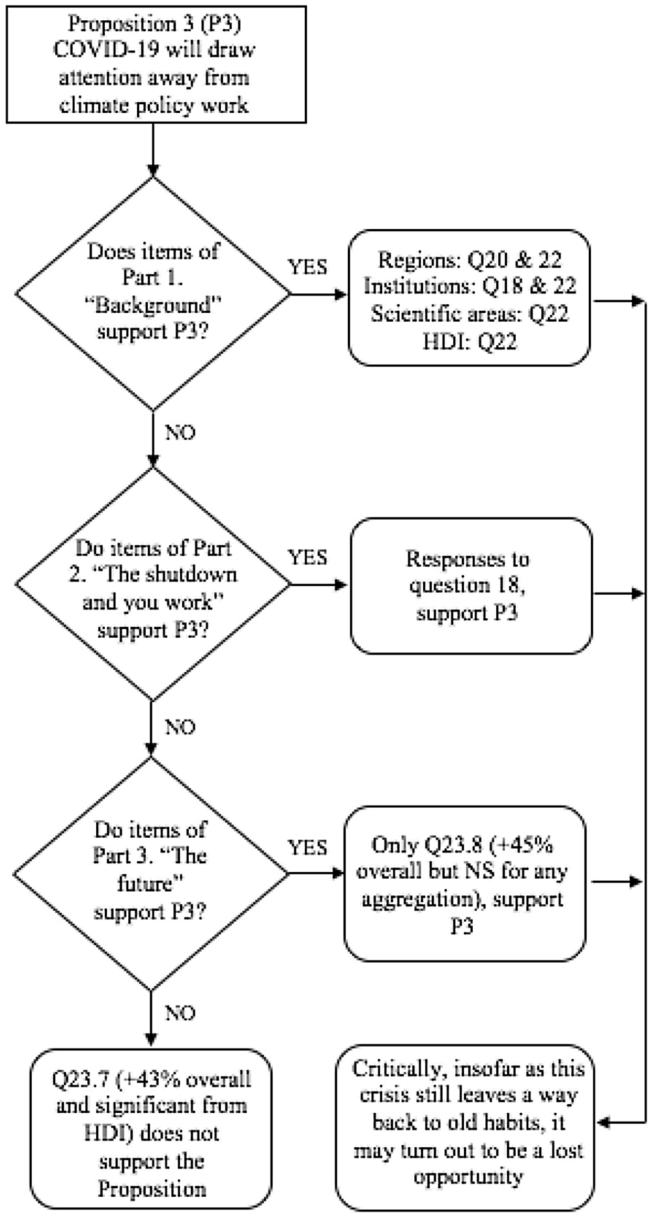

Fig. 6. Flowcharts showing the responses to the survey's parts and their relationship with P-3 and selected statements.

the inferential statistics of the aggregations, the "Institution" shows a shallow level of significant responses and a large internal difference. The three other aggregations (Scientific, HDI and Region) show similar (12, 13, and 14, respectively) but different and complementary responses. Noteworthy, Asia and North America are less and more affected by the shutdown (Q7), which could be associated with different expectations, mainly from North Americans. Only the Regions and HDI aggregations highlight "Inclusion of references to COVID 19 in research/project" and "Global cooperation on tackling climate change", respectively, mainly in Africa and LAC. On the other hand, most answers regarding the available infrastructure and communication access (11–12) highlight Africa's insufficient infrastructure.

Concerning the Scientific areas, the research activities and workload from Climate Sciences are less affected by the Pandemic than Agrarian and Biological Sciences, despite the latter being not too much affected by the shutdown.

Regarding the HDI aggregation, the difference between Very High and Others is prominent. Although the results are similar to Regions (Table 5), their differences support creating an HDI aggregation. Interestingly, Africa's agreement to Q 20 (will the COVID-19 crisis influence your research…?) was very high (77 %).

Regarding the propositions:

P1) COVID-19 has changed how climate scientists work. The responses to the questions (12, 13,15,17,18, 20, 21, 23) support this statement, being greater from Regional, Scientific and HDI aggregations. The independent variable Institutions is less an explanatory variable than the others (Table 5). Responses 23.4 and 23.7 suggest that the pandemic presents an opportunity to take positive actions towards tackling climate change. "*We cannot predict or control external events, but we can decide how we respond*" (The Economist, March 26, 2020).

Over half of the sample had their work affected by the pandemic. However, most respondents stated a relatively high level of satisfaction with the degree of support they received during the lockdowns. Nevertheless, the availability of work tools did not prevent over half of the sample from suffering from the impacts of not interacting with their peers. The research workload increase (Q15) of Climate Scientists is likely due to less dependence on fieldwork.

P2) There are signs that COVID 19 is already influencing the direction of climate policy research. The responses to questions 13, 17–21, 23 support this statement, while Q19, related to the importance of CO_2 emissions, is in line with the literature (e.g., Le Quéré et al., 2020), and there is much more research on the topics directly related with ecosystems, health and climate (Bayer et al., 2021) and many others) which support that "*there are important shared challenges between COVID-19 and climate change crises*" (Manzanedo and Manning, 2020). "*Climate change and COVID-19 are two global crises whose mutual impacts on human health are not yet well understood. Nevertheless, even though their urgency and scales are not uniform, both crises show that urgent action to handle them is needed.*" (Leal Filho et al., 2020b),

P3) During March-April 2020, COVID-19 has drawn attention away from climate policy. The responses to Q18 (Institutions) and particularly Q22 (Institution), Q20 (Region), and 22 (Region, Scientific, HDI) support this statement, as well as 23.8 (N.S.) does.

The results obtained show that whereas over half of the sample had their work negatively influenced by the pandemic, most of the sample stated a relatively high level of satisfaction with their organisations and the degree of support they have received for their work the lockdowns (8,11,12). Nevertheless, the availability of work tools did not prevent over half of the sample from suffering from the impacts of not interacting with their peers due to the need for self-isolation (13–17).

Instead of being a temporary problem, these trends suggest that the pandemic impacts on climate change research will still be felt in years to come.

5.3. Limitations of the paper

Given the complex nature of COVID-19, it is inevitable that more time is needed to understand its actual impacts. Only the future will provide us with greater certainty. The data and analysis in this study pertain specifically to the pandemic's initial wave, providing more excellent scientific value for this period.

Similarly, the sample is small to allow for definitive conclusions to be reached. However, it provides a sound profile of the trends seen during the first wave of the pandemic so that this research becomes an extensive study on the nexus of COVID-19 and climate change performed so far. The paper has identified some facts that are not evident from the currently available literature. It specifically relates to the influences of the COVID-19 epidemic on climate change research.

5.4. Implications of the study

By understanding that lifestyle changes to deal with COVID-19 are possible, researchers and policymakers can use this as a learning experience to deal with climate change. The lessons from COVID-19 are vital

in climate policy-making due to the similarities (Botzen et al., 2020). During the pandemic, the imposed lockdowns led to positive environmental changes at the cost of economic downfalls, emphasising that immediate and abrupt changes in behaviour reduce some adverse environmental effects. Therefore, policies need to be designed to ensure that similar results are achieved in a more planned manner that allows long-term benefits (Howarth et al., 2020).

The COVID-19 pandemic experience highlights the advantage of policies that utilise the disruption created to accelerate carbon use reduction, as was observed during the first wave. Secondly, policies can promote low carbon innovation by incorporating such ideas into the COVID-19 recovery programmes, thereby catalysing changes already in motion before the pandemic (Markard and Rosenbloom, 2020).

"Governments will be faced with developing and adjusting policies that address not only the pandemic itself, but also potential collisions and intersections with other regional or global crises" (Phillips et al., 2020, pp 586). Therefore, we hope that "*COVID-19 recovery* programs *can lay the foundation for a more sustainable and prosperous future*." (Rosenbloom and Markard, 2020, pp 447).

6. Conclusions

This paper has analysed how the COVID-19 pandemic has influenced or is likely to affect climate action worldwide. The survey, which involved representatives from universities, government organisations, NGOs, and international organisations, has assessed the current and expected level of emphasis given to climate change research during the pandemic.

The implications of the paper are threefold. It has shed some light on how the pandemic influenced climate change research (see P1). For instance, measures that may prevent such negative impacts from occurring again (e.g., communication tools) may be pursued. Also, most respondents stated that COVID-19 could be included in their research, suggesting that many future papers will focus on the connections between COVID-19 and climate change (see P2). Finally, many respondents stated that the pandemic had drawn attention away from climate policy (see P3), which the authors believe is still valid by the beginning of 2021.

The paper reflects the respondents' views during the first wave of the pandemic. After a year, it should be interesting to repeat the study.

The authors hope that the data and trends identified in the paper may support efforts to understand better the connections between the COVID-19 pandemic and climate change. The development of vaccines for COVID-19 will reduce the scope of the disease. However, climate change as a problem will persist long after COVID-19 has been controlled. If the current lessons from both global crises are learned, and the right policies and measures are set up, the world may be better positioned to cope with global climate change, which impacts are felt at the local level.

Author Contributions

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Draft; Review & Editing, Supervision, Project administration. Tony Wall: Methodology,

Investigation, Writing - Original Draft - Review & Editing. Fátima Alves: Methodology, Writing - Original Draft. Gustavo J Nagy: Methodology, Formal analysis, Investigation, Writing - Original Draft; - Review & Editing. Luis Ricardo Fernández Carril: Investigation, Writing - Original Draft. Chunlan Li: Software, Formal analysis, Visualization. Serafino Mucova: Formal Analysis, Writing - Original Draft. Johannes

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Review & Editing. Antonio Garcia Vinuesa: Software, Formal analysis. Aprajita

Minhas: Investigation

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.envsci.2021.06.008.

References

Ali, W., 2020. Online and remote learning in higher education institutes: a necessity in light of COVID-19 pandemic. High. Educ. 10 (3).

Anthem, P., 2020. Risk of hunger pandemic as COVID-19 set to almost double acute hunger by end of 2020. World Food Programme. Retrieved from: https://insight.wfp.org/covid-19-will-almost-double-people-in-acute-hunger-by-end-of-2020-59df0c4a8072.

Barrett, E., 2020. The coronavirus pandemic shows how governments could respond to climate change. Fortune. March 12. Retrieved from: https://fortune.com/2020/03/12/coronavirus-climate-change-response/.

Bayer, R.M., Manica, A., Mora, C., 2021. Shifts in global bat diversity suggest a possible role of climate change in the emergence of SARS-CoV-1 and SARS-CoV- 2. Sci. Total Environ. 767, 145413. https://doi.org/10.1016/j.scitotenv.2021.145413.

Berwyn, B., 2020. Coronavirus Already Hindering Climate Science, But the Worst Disruptions Are Likely Yet to Come. Retrieved from: https://insideclimatenews.org/news/26032020/coronavirus-climate-science-research-impact.

Botzen, W., Duijndam, S., van Beukering, P., 2020. Lessons for climate policy from behavioral biases towards COVID-19 and climate change risks. World Dev. 137, 105214. https://doi.org/10.1016/j.worlddev.2020.105214.

Bryman, A., 2016. Social Research Methods, 5th edn. Oxford University Press, Oxford, U.K.

Clarkson, H., 2020. International climate ministers meet to discuss green recovery post COVID-19. The Climate Group. April 26. Retrieved from: https://www.theclimategroup.org/news/international-climate-ministers-meet-discuss-green-recovery-post-covid-19.

Cooper, R., 2020. Coronavirus: Scientists Reveal Reduction in Global Air Pollution and Nitrogen Dioxide Levels. April 28. Retrieved from. http://www.climateaction.org/news/coronavirus-scientists-reveal-reduction-in-global-air-pollution-and-nitroge.

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Lam, S., 2020. COVID-19: 20 countries' higher education intra-period digital pedagogy responses. J. Appl. Learn. Teach. 3 (1), 1–20.

Creswell, J.W., 2013. Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 3rd ed. Sage, Thousand Oaks.

Creswell, J.W., 2014. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th ed. C.A., USA: Thousand Oaks.

Creswell, J.W., Creswell, J.D., 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th ed. Sage, London.

Gornall, J., 2020. Climate Change will still be a Threat after COVID-19 is gone. March 17. Retrieved from:. EURACTIV https://www.euractiv.com/section/climate-environment/opinion/climate-change-will-still-be-a-threat-after-covid-19-is-gone/.

Halbrügge, S., Schott, P., Weibelzahl, M., Buhl, H.U., Fridgen, G., Schöpf, M., 2021. How did the German and other European electricity systems react to the COVID-19 pandemic? Appl. Energy 285, 116370. https://doi.org/10.1016/j.apenergy.2020.116370.

Hamwey, R., 2020. Environmental Impacts of Coronavirus Crisis, Challenges Ahead. April 28. Retrieved from: https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2333.

Holmes, E.A., O'Connor, R.C., Perry, V.H., Tracey, I., Wessely, S., Arseneault, L., Ballard, C., Christensen, H., Cohen Silver, R., Everall, I., Ford, T., John, A., Kabir, T., King, K., Madan, I., Michie, S., Przybylski, A.K., Shafran, R., Sweeney, A., Worthman, C.M., Yardley, L., Cowan, K., Cope, C., Hotopf, M., 2020. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. Lancet Psychiatry. April 15, Retrieved from. https://www.thelancet.com/pdfs/journals/lanpsy/PIIS2215-0366(20)30168-1.pdf.

Howarth, C., Bryant, P., Corner, A., Fankhauser, S., Gouldson, A., Whitmarsh, L., Willis, R., 2020. Building a social mandate for climate action: lessons from COVID-19. Environ. Resour. Econ. 76 (4), 1107–1115. https://doi.org/10.1007/s10640-020-00446-9.

Johns Hopkins University, 2020. Coronavirus Resource Center. Retrieved from: https://coronavirus.jhu.edu/map.html.
Kahneman, D., 2011. Thinking, Fast and Slow. Penguin Books, London.
Le Quéré, C., Jackson, R.B., Jones, M.W., 2020. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. Nat. Clim. Chang. 10, 647–653.
Leal Filho, W., Azul, A.M., Wall, T., Vasconcelos, C.R.P., Salvia, A.L., Do Paço, A., Shulla, K., Levesque, V., Doni, F., Alvarez-Castañón, L., Mac-Lean, C., Avila, L.V., Damke, L.I., Castro, P., Azeiteiro, U.M., Fritzen, B., Ferreira, P., Frankenberger, F., 2020a. COVID-19: The Impact of a Global Crisis on Sustainable Development Research Sustainability Science. https://doi.org/10.1007/s11625-020-00866-y.
Leal Filho, W., Nagy, G.J., Ayal, D.A., 2020b. Viewpoint: climate change, health and pandemics – a wake-up call from COVID-19. Int. J. Clim. Chang. Strateg. Manag. 12 (No. 4), 533–535. https://doi.org/10.1108/IJCCSM-08-2020-212.
Leal Filho, W., Price, E., Wall, T., Shiel, C., Azeiteiro, U.M., Mifsud, M., Brandli, L., Farinha, C., Caeiro, S., Salvia, A.L., Vasconcelos, C.R., de Souza, L., Pace, P., Doni, F., Avila, L., Fritzen, B.M., LeVasseur, T.J., 2021. COVID-19: the impact of a global crisis on sustainable development teaching Environment. Dev. Sustainabil. https://doi.org/10.1007/s10668-020-01107-z.
Manzanedo, R.D., Manning, P., 2020. COVID-19: lessons for the climate change emergency. Sci. Total Environ. 742, 140563. https://doi.org/10.1016/j.scitotenv.2020.140563.
Markard, J., Rosenbloom, D., 2020. A tale of two crises: COVID-19 and climate. Sustain. Sci. Pract. Policy 16 (1), 53–60. https://doi.org/10.1080/15487733.2020.1765679.
Martinez-Diaz, L., Sidner, L., 2020. Key Investments Can Build Resilience to Pandemics and Climate Change. Retrieved from: https://www.wri.org/blog/2020/04/coronavirus-pandemic-climate-change-investments.
McKeever, V., 2020. Nearly 25 Million Jobs Could Be Lost Globally Due to the Coronavirus, U.N. Labor Organisation Estimates. CNBC March 19. Retrieved from: https://www.cnbc.com/2020/03/19/nearly-25-million-jobs-could-be-lost-globally-due-to-the-coronavirus.html.
Miki, E., 2020. Lockdown is revealing a lot of existing tensions in society. An Interview with Medical Sociologist Robert Dingwall, N.H.K.. April 25. Retrieved from: https://www3.nhk.or.jp/nhkworld/en/news/backstories/1042/.
OECD, 2020. COVID – 19 and the Low-Carbon Transition. Impacts and Possible Policy Responses. June 26. Retrieved from. http://www.oecd.org/coronavirus/policy-responses/covid-19-and-the-low-carbon-transition-impacts-and-possible-policy-responses-749738fc/.
Phillips, C.A., Caldas, A., Cleetus, R., 2020. Compound climate risks in the COVID-19 pandemic. Nat. Clim. Change 10, 586–588. https://doi.org/10.1038/s41558-020-0804-2.
Platje, J., 2011. Institutional Capital - Creating Capacity and Capabilities for Sustainable Development. Wydawnictwo Universytetu Opolskiego, Opole.
Punch, K.F., 2014. Introduction to Social Research: Quantitative & Qualitative Approaches, 3rd edn. Sage, London.
Purdy, L., 2020. Corona Virus Could Cause Fall in Global CO2 Emissions. April 28. Retrieved from: https://www.positive.news/environment/coronavirus-could-cause-fall-in-global-co2-emissions-say-analysts/.
Rosenbloom, D., Markard, J., 2020. A COVID-19 recovery for climate. Science 368 (6490), 447. https://doi.org/10.1126/science.abc4887.
Rugani, B., Caro, D., 2020. Impact of COVID-19 outbreak measures of lockdown on the Italian Carbon Footprint. Sci. Total Environ. 737, 139806.
Sauven, J., 2020. COVID-19 Needs Our Attention Right Now, but Recovery Measures Could be Part of the Solution for the Climate Emergency. Greenpeace. March 20. Retrieved from: https://www.greenpeace.org.uk/news/covid-19-coronavirus-needs-our-attention-right-now-recovery-measures-could-be-part-of-the-solution-for-climate-nature-emergency/.
Stone, M., 2020. Carbon emissions are falling sharply due to coronavirus. But Not for Long. April 28. Retrieved from: https://www.nationalgeographic.co.uk/environment-and-conservation/2020/04/carbon-emissions-are-falling-sharply-due-coronavirus-not-long.
The Economist, 2020. The epidemic provides a chance to do good by the climate. The Economist. March 26. Retrieved from: https://www.economist.com/science-and-technology/2020/03/26/the-epidemic-provides-a-chance-to-do-good-by-the-climate.
U.N, 2020. Secretary-General's Remarks to Petersberg Climate Dialogue. Retrieved from: https://www.un.org/sg/en/content/sg/statement/2020-04-28/secretary-generals-remarks-petersberg-climate-dialogue-delivered.
UNDP, 2015. Human development for everyone. Human Development Report 2015. United Nations Development Program, New York, NY, USA, 2016. Retrieved from: http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf.
Van Dam, Y.K., Webbink, J.F., 2020. Reflecting on reflections on covid-19. Cent. Eur. Rev. Econ. Manag. 4 (2), 7–19. https://doi.org/10.29015/cerem.876.
Wang, Lin-Fa, Anderson, Danielle E., Mackenzie, John S., Merson, Michael, H., 2020. From Hendra to Wuhan: what has been learned in responding to emerging zoonotic viruses. Lancet 33–34. https://doi.org/10.1016/S0140-6736(20)30350-0, 395.
World Economic Outlook Reports, 2020. A Crisis Like No Other, An Uncertain Recovery Update, June 2020. Retrieved from:. International Monetary Fund https://www.imf.org/en/Publications/WEO.
World Food Programme, 2020. 2020 - Global Report on Food Crises. Retrieved from:. United Nations World Food Programme (WFP) https://www.wfp.org/publications/2020-global-report-food-crises.
Wynes, A., 2020. How Climate Change and the Coronavirus Are Linked. Retrieved from: https://www.preventionweb.net/news/view/71155.